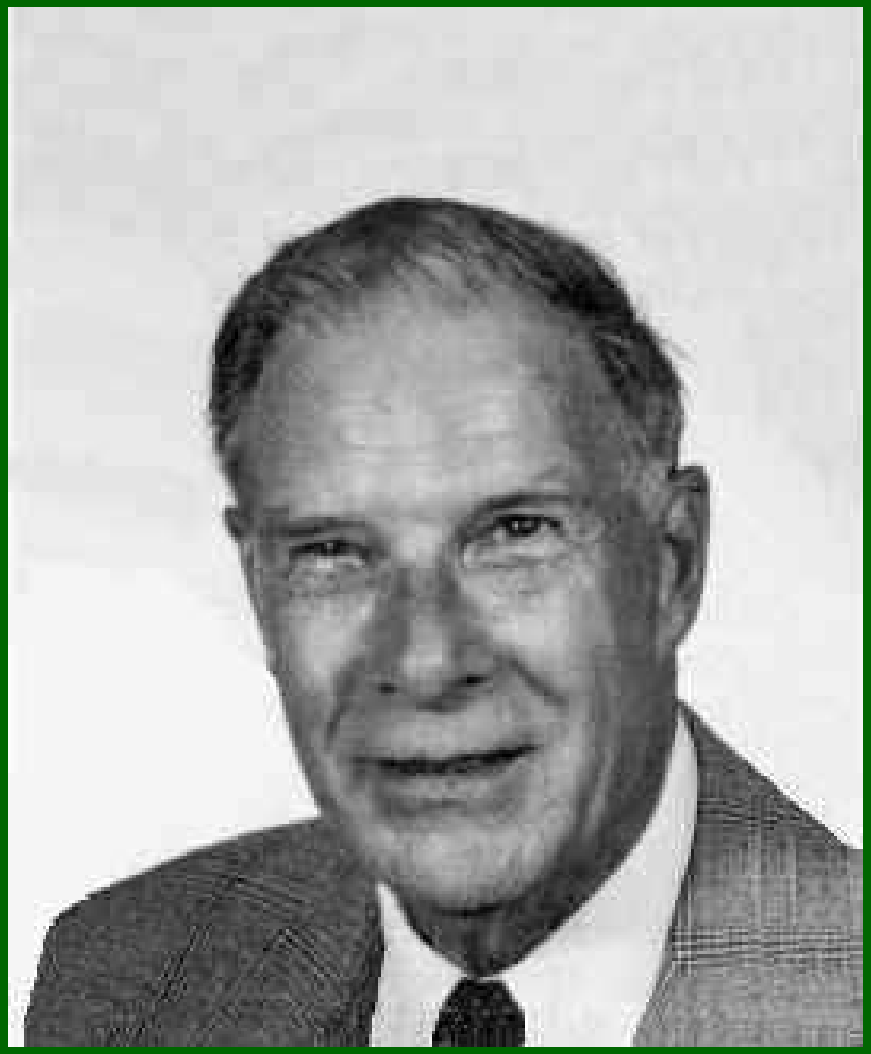
Richard W. Hamming

Learning to Learn

The Art of Doing Science and Engineering

Superintendent's Guest Lecture

30 April 1990



Editorial note

Dr. Hamming's Superintendent's Guest Lecture (SGL) presentation is an excellent summary of the many diverse, challenging ideas tackled in his book and course.

These slides summarize Dr Hamming's background, contributions, awards and publications as listed in his curriculum vita.

Richard W. Hamming

Born: 11 Feb 1915 in Chicago Illinois USA

Died: 7 Jan 1998 in Monterey California USA

Degrees Received

- 1942, Ph.D., Mathematics, University of Illinois
- 1939, M.A., Mathematics, University of Nebraska
- 1937, B.S., Mathematics, University of Chicago

Richard W. Hamming

Work Experience

- 1945-46 Los Alamos Lab, Manhattan Project
  - *Atomic Bomb Numerical Calculation Research*
- 1946-1976 Bell Laboratories
  - *Mathematics and computing as applied to military and telephone research*
  - *Adjunct Professor of Statistics, Princeton, 3 years*
- 1976-1998, Naval Postgraduate School, Professor

Richard W. Hamming

Honors

- President, Association Computing Machinery
- Turing Prize of ACM
- Fellow IEEE
- Piore Prize, 1979
- National Academy of Engineering, 1980
- Pender Prize, 1981

Richard W. Hamming

Honors

- IEEE R. W. Hamming Gold Medal namesake
  - *First recipient, $10,000 prize, 1996*
  - *“For exceptional contributions to information sciences and systems”*
- Vice President, Math Section, American Association for the Advancement of Science (AAAS)
- Editor of numerous journals

Quotable quotes
1

The purpose of computing is insight, not numbers.

It is better to do the right problem the wrong way, than the wrong problem the right way.

Quotable quotes 2

Mathematics is the language of clear thinking.

If the prediction that an airplane can stay up depends on the difference between Riemann and Lebesgue integration, then I don’t want to fly in it.

Quotable quotes 3

Mathematics is an interesting intellectual sport but it should not be allowed to stand in the way of obtaining sensible information about physical processes.

- Quoted in N. Rose *Mathematical Maxims and Minims* (Raleigh NC 1988).

Quotable quotes 4

I bugged Claude Shannon for years and years to write a book on Information Theory so that everyone would understand it. He refused, so I went ahead & wrote it.

A good theoretician can account for almost any result that is produced, right or wrong.

Quotable quotes 5

My doctoral dissertation was 27 pages long.

- *Some Problems in the Boundary Value Theory of Linear Differential Equations*
- *University of Illinois at Urbana-Champaign, 1942*

[“… uhh, why so short, Dr. Hamming??”]

There was a lot less to know in 1942.

- *see chapter 1, exponential growth of knowledge*

Quotable quotes 6

If you don't work on important problems, it's not likely that you'll do important work.

Usually expressed as a thought-provoking challenge to the audience:

- Who here wants to do important work in their career?
- Who here is working on important problems?
- (for those not raising a hand) Why not?

Hamming on Hamming: Learning to Learn

Courses

Hamming: Learning to Learn

Organizer: Richard W. Hamming (Naval Postgraduate School)

"The Art of Doing Science and Engineering: Learning to Learn" was the capstone course by Dr. Richard W. Hamming (1915-1998) for graduate students at the Naval Postgraduate School (NPS) in Monterey California. This course is intended to instill a "style of thinking" that will enhance one's ability to function as a problem solver of complex technical issues. With respect, students sometimes called the course "Hamming on Hamming" because he relates many research collaborations, discoveries, inventions and achievements of his own. This collection of stories and carefully distilled insights relates how those discoveries came about. Most importantly, these presentations provide objective analysis about the thought processes and reasoning that took place as Dr. Hamming, his associates and other major thinkers, in computer science and electronics, progressed through the grand challenges of science and engineering in the twentieth century.

	Presentation	Presenter, Affiliation
30 April 1990	Superintendent's Guest Lecture (SGL)	Richard W. Hamming, Naval Postgraduate School
28 March 1995	Orientation	Richard W. Hamming, Naval Postgraduate School
30 March 1995	Foundations of the Digital (Discrete) Revolution	Richard W. Hamming, Naval Postgraduate School
31 March 1995	History of Computers - Hardware	Richard W. Hamming, Naval Postgraduate School
4 April 1995	History of Computers - Software	Richard W. Hamming, Naval Postgraduate School

28 March 1995	Orientation	Richard W. Hamming, Naval Postgraduate School
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4 April 1995	History of Computers - Software	Richard W. Hamming, Naval Postgraduate School
6 April 1995	History of Computer Applications	Richard W. Hamming, Naval Postgraduate School
7 April 1995	Artificial Intelligence (AI) - I	Richard W. Hamming, Naval Postgraduate School
11 April 1995	Artificial Intelligence (AI) - II	Richard W. Hamming, Naval Postgraduate School
13 April 1995	Artificial Intelligence (AI) - III	Richard W. Hamming, Naval Postgraduate School
14 April 1995	n-Dimensional Space	Richard W. Hamming, Naval Postgraduate School
18 April 1995	Coding Theory - I	Richard W. Hamming, Naval Postgraduate School
20 April 1995	Coding Theory - II	Richard W. Hamming, Naval Postgraduate School
21 April 1995	Error Correcting Codes	Richard W. Hamming, Naval Postgraduate School
25 April 1995	Information Theory	Richard W. Hamming, Naval Postgraduate School
27 April 1995	Digital Filters - I	Richard W. Hamming, Naval Postgraduate School
28 April 1995	Digital Filters - II	Richard W. Hamming, Naval Postgraduate School
2 May 1995	Digital Filters - III	Richard W. Hamming, Naval Postgraduate School
4 May 1995	Digital Filters - IV	Richard W. Hamming, Naval Postgraduate School
5 May 1995	Simulation - I	Richard W. Hamming, Naval Postgraduate School
9 May 1995	Simulation - II	Richard W. Hamming, Naval Postgraduate School
11 May 1995	Simulation - III	Richard W. Hamming, Naval Postgraduate School
12 May 1995	Fiber Optics	Richard W. Hamming, Naval Postgraduate School

28 April 1995	Digital Filters - II	Richard W. Hamming, Naval Postgraduate School
2 May 1995	Digital Filters - III	Richard W. Hamming, Naval Postgraduate School
4 May 1995	Digital Filters - IV	Richard W. Hamming, Naval Postgraduate School
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11 May 1995	Simulation - III	Richard W. Hamming, Naval Postgraduate School
12 May 1995	Fiber Optics	Richard W. Hamming, Naval Postgraduate School
16 May 1995	Computer Aided Instruction - CAI	Richard W. Hamming, Naval Postgraduate School
18 May 1995	Mathematics	Richard W. Hamming, Naval Postgraduate School
19 May 1995	Quantum Mechanics	Richard W. Hamming, Naval Postgraduate School
23 May 1995	Creativity	Richard W. Hamming, Naval Postgraduate School
25 May 1995	Experts	Richard W. Hamming, Naval Postgraduate School
26 May 1995	Unreliable Data	Richard W. Hamming, Naval Postgraduate School
30 May 1995	Systems Engineering	Richard W. Hamming, Naval Postgraduate School
1 June 1995	You Get What You Measure	Richard W. Hamming, Naval Postgraduate School
2 June 1995	How Do We Know What We Know	Richard W. Hamming, Naval Postgraduate School
6 June 1995	You and Your Research	Richard W. Hamming, Naval Postgraduate School

E-mail production comments. MV4000 is meeting in ME-285 every Friday 1400-1530, Jaunuar-March 2004, to discuss the Hamming lecture series.

Hamming on Hamming: Learning to Learn

Hamming: Learning to Learn

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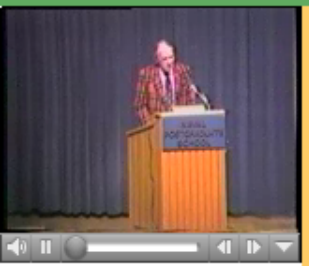

Presenter:
Richard W. Hamming
Naval Postgraduate School

Presentation:
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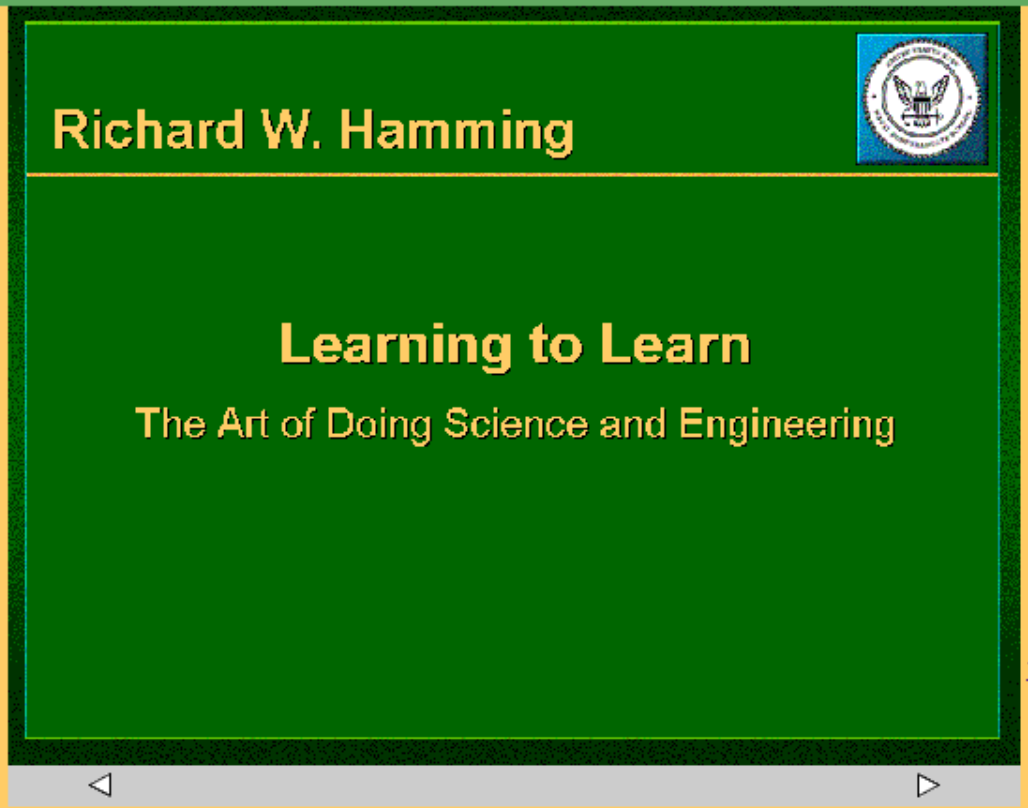

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Dr. Hamming's presentation to all students and faculty in the 1990 NPS Superintendent's Guest Lecture (SGL) provides a synopsis overview of many of the most fundamental ideas encountered in

Reflections on Los Alamos (Manhattan Project, World War II)

- Wartime call to service.
- “Janitor of science” and first computers.
- To perform great work, study the masters.
- No two histories of the time are consistent.
- Thoughts on the accuracy of the computed O^{18} radiative-absorption cross section for slow neutrons, considered on the day prior to the detonation of the first atomic device.

Namesake Concepts 1

Hamming error-correcting codes:

Carefully added redundancy which allows automatic detection & correction of errors.

- Hamming bits: redundancy built into hardware

Forward error correction:

Sufficient redundancy that a receiver (on forward side) can correct errors without retransmission by original sender.

Namesake Concepts 2

Hamming distance:

The number of positions which differ when comparing corresponding bits between two code words.

Sometimes used as a measure of conceptual distance, rather than spatial or numerical distance.

Namesake Concepts 3

Hamming predictor-corrector (PC) set for ordinary differential equations:

One of numerous numerical-analysis techniques used to make computer computations accurate by damping out progressive roundoff errors. Overcomes a fundamental limitation of discrete arithmetic processing implemented in computer systems.

Namesake Concepts
4

Hamming digital filter

Application of digital techniques (discrete computer processing) to perform signal processing, historically possible only with analog electronic circuitry.

Richard W. Hamming

Books Authored

- Numerical Methods for Scientists and Engineers
- Computers and Society
- Introduction for Applied Numerical Analysis
- Calculus and the Computer Revolution
- Digital Filters (3rd Edition, January 1989)
- The Art of Doing Science and Engineering, Learning to Learn

Richard W. Hamming

Papers Authored

- A Class of Integration Formulas
- The Computer as an Experimental Tool
- A Computer Scientist Looks at Statistics
- Error Detecting and Error Correcting Codes
- Impact of Computers
- Educational Implications of the Computer Revolution

Richard W. Hamming

Papers Authored

- Intellectual Implications of the Computer Revolution
- One Man's View of Computer Science
- Introduction to "Fundamental Theory of Servomechanisms"
- The Mechanization of Science
- A Note on the Location of the Binary Point in a Computing Machine

Richard W. Hamming

Papers Authored

- Nuclear Magnetic Resonance in Crystals
- Numerical Analysis vs. Mathematics
- Pitfalls in Numerical Analysis- IEEE Talk, March 19, 1968
- Numerical Evaluation of Electron Image Phase Contrast
- Stable Predictor-Corrector Methods for Ordinary Differential Equations

Richard W. Hamming

Papers Authored

- The Impact of Computer technology on Management Concepts, Planning, and Decision Making
- Checking Techniques for Digital Computers
- Social Implications of the Computer Revolution
- The Effects of Computers Upon Engineering Education

Richard W. Hamming

Papers Authored

- Mathematical Notes
- Controlling the Digital Computer
- Computer Appreciation Courses
- Convergent Monotone Series
- Monotone Series
- An Essay on Computer Science Training Programs
- The Transcendental Character of COS X

Richard W. Hamming

Papers Authored

- On the Distribution of Numbers
- Modern Control Theory
- A Class of Integration Formulas
- Computers and Society
- An Elementary Discussion of the Transcendental Nature of the Elementary Transcendental Functions
- Contributing to Modern Science and Engineering

Richard W. Hamming

Papers Authored

- Note on the Teaching of Trigonometry
- Effects of Computers Upon Engineering Education
- Electronic Digital Computer as an Intellectual Tool
- General Purpose System
- Standard for Computer Mathematics

Richard W. Hamming

Papers Authored

- Thinking Big Even with Small Computers
- Limitations of Computers
- A Philosophy of Computer Science of My Prejudices and Confusions
- How Do You Know the Simulation is Relevant?
- A History of Computing in the United States
- Fifth Generation Computers and Beyond

Richard W. Hamming

Papers Authored

- Invariance and Bertrands Paradox
- The Role of the Digital Computer in Scientific Research, Past, Present, and Future
- Gaussian Quadrature as a Minimization Principle
- Error Correcting Codes
- The Role of the Technical Societies in the Field of Computer Measurement

Richard W. Hamming

Papers Authored

- Statistical Estimation of Error Propagation Through Multiplication and Division
- A Systems Approach to Software Testing
- Noninterpolatory Quadrature Formulas
- The Frequency Approach to Numerical Analysis
- Compumetrics: The Way Ahead
- Computers and Computing in the ’70’s

Richard W. Hamming

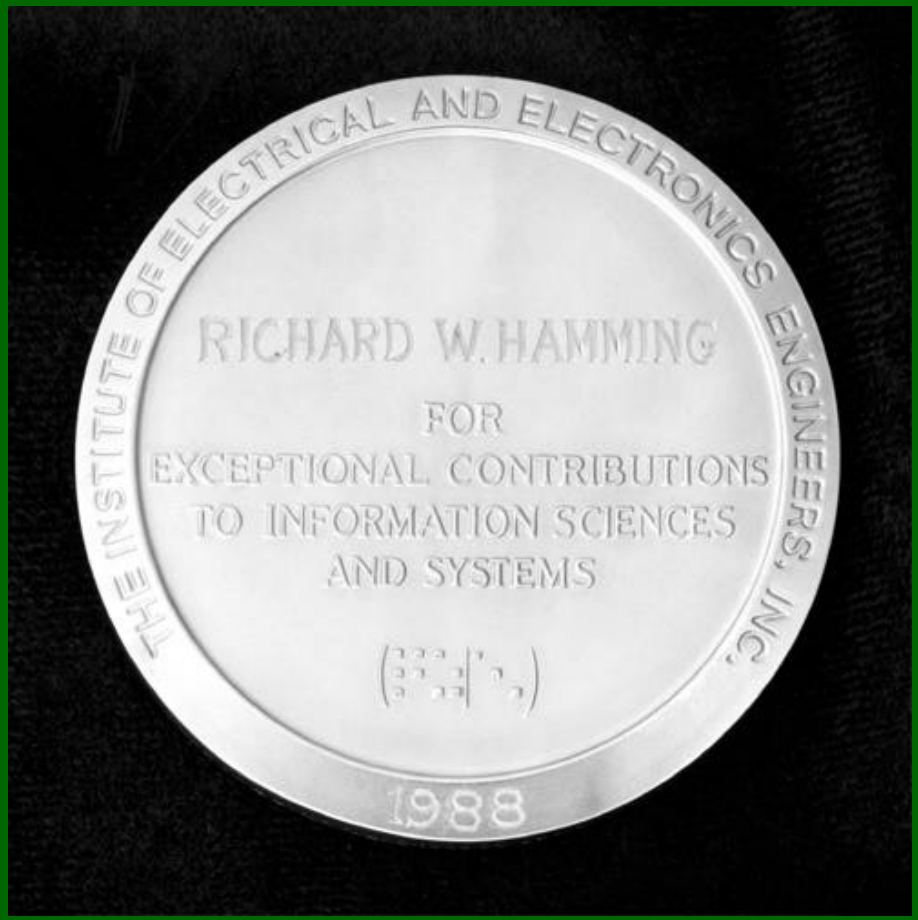
Papers Authored

- Commencement Talk to Engineering School, University of California, Irvine
- The Distribution of Numbers- Applications
- The Distribution of Numbers- Mathematical Theory
- The Distribution of Numbers- Computer Theory
- The Distribution of Numbers- Physical Theory

Richard W. Hamming

Papers Authored

- Some Thoughts on Simulation
- Band Limited Functions
- Velocity Dependence on Contrast in Electron Images of Periodic Structures


THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.
RICHARD W. HAMMING
FOR
EXCEPTIONAL CONTRIBUTIONS
TO INFORMATION SCIENCES
AND SYSTEMS
1988

Favorite quote

Luck favors the prepared mind.

- Louis Pasteur, 1822-1895